BEXQ

Kinkead

STANDARDS DEVELOPMENT BRANCH OMOE
36936000009107

ONTARIO

Ministry of the ENVIRONMENT

Water Quality Investigation of Jackfish Bay Lake Superior

September 1972

Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact ServiceOntario Publications at copyright@ontario.ca

Environment Ontario

WATER QUALITY INVESTIGATION

OF

JACKFISH BAY

LAKE SUPERIOR

SEPTEMBER 1972

TABLE OF CONTENTS

PAGE NO.

INTRODUCTION 1

1. SUMMARY OF FINDINGS AND RECOMMENDATIONS 3

  1.1 Summary of Findings 3
  1.2 Recommendations 4

2. DESCRIPTION OF STUDY AREA 7

  2.1 General Description 7
  2.2 Water Uses 7

3. SURVEY OUTLINE 9

  3.1 Water Quality Study 9
  3.2 Sediment Samples 9

4. FINDINGS AND DISCUSSION 11

  4.1 Waste Sources 11
  4.2 Water Quality 11
  4.3 Sediments 14

5. WATER QUALITY CONTROL 15

  5.1 Water Quality Standards 15

APPENDIX A - METHODS 21

  A.1 Water Quality Sampling 21
  A.2 Sediment Samples 21

APPENDIX B - ANALYTICAL RESULTS 25

LIST OF FIGURES

FIGURE NO.		PAGE NO.
1	Location of Jackfish Bay on Lake Superior	5
2.1	Study Area Showing Blackbird Creek and Jackfish Bay	8
4.1	BOD_5 Levels in Jackfish Bay	12
4.2	Dissolved Oxygen Levels in Jackfish Bay	12
4.3	Colour Levels in Jackfish Bay	12
A.1	Locations of Sampling Stations in Jackfish Bay.	22

LIST OF TABLES

TABLE NO.		PAGE NO.
5.1	Proposed Water Quality Standards for Sections of Jackfish Bay	17
B.1	Waste Loadings from the Terrace Bay Mill of the Kimberly-Clark Pulp and Paper Company Limited	25
B.2	Summary of Water Quality Data, 1970 Jackfish Bay	26
B.3	Content of Organic Matter and Mercury in Sediments - Jackfish Bay.	27

INTRODUCTION

This report presents the findings of a water quality investigation conducted in August 1970 by the Water Quality Branch of the Ontario Ministry of the Environment (formerly OWRC) in Jackfish Bay on the north shore of Lake Superior, approximately 150 miles east of the City of Thunder Bay (Figure 1). The study was requested by the Industrial Wastes Branch of the Ministry to evaluate the environmental effects of the wastewater discharges into Jackfish Bay via the Blackbird Creek system from the Terrace Bay bleached kraft mill of the Kimberly-Clark Pulp and Paper Company Limited. Demand for the investigation was also promoted by the numerous complaints on the offensive odour and appearance of Blackbird Creek by passing motorists.

An earlier biological investigation* revealed impairment of bottom fauna in the westerly arm (Moberly Bay) of Jackfish Bay. Subsequent to the biological study, environmental studies elsewhere showed the mercurial slimicides and fungicides commonly used at pulp and paper mills could be concentrated in fish and other aquatic organisms which upon consumption could present a hazard to human health. Consequently, bottom sediments in the area were examined for the presence of mercurial compounds during the 1970 study.

Following a discussion of the water quality problems, a set of preliminary water quality standards are presented for Jackfish Bay area of Lake Superior.

* *OWRC Biological Investigation of Jackfish Bay, Lake Superior, 1969.*

1. SUMMARY OF FINDINGS AND RECOMMENDATIONS

1.1 SUMMARY OF FINDINGS

The wastewater discharges from the Terrace Bay mill of the Kimberly-Clark Pulp and Paper Company Limited have seriously impaired the water quality and aesthetic value of the Blackbird Creek system and to a lesser degree the water quality of the westerly arm (Moberly Bay) of Jackfish Bay.

At the time of this study, the wastewater discharges from the mill were 46 cfs. The biochemical oxygen demand (BOD_5), dissolved solids and suspended solids contained in these discharges amounted to 91,000, 330,000 and 13,000 lbs per day, respectively. The reduction of waste materials in the Blackbird Creek system, which is used to carry the mill wastes to Jackfish Bay and which is basically the company's waste treatment system, was insignificant except for suspended solids which were reduced by about 50 percent (from 105 mg/l to 53 mg/l).

The alterations in water quality of Jackfish Bay included increases in the concentration of oxygen-consuming wastes (BOD_5, COD), phenolic substances, colour and turbidity and bacterial contamination. In general, the changes in water quality were limited to a distance of about 1 1/4 miles from the mouth of Blackbird Creek. The oxygen-consuming wastes did not depress the concentration of dissolved oxygen in Moberly Bay below 6.0 mg/l which is above the 6.0 mg/l level considered to be necessary for protection of cold water fisheries and other desirable aquatic life. Bacterial contamination in excess of accepted criteria for swimming and bathing was found to occur within a 3/4 mile range from the creek mouth at the time of this study.

The degradation in the aesthetic quality due to odour, floating foam and dark brown colour of Blackbird Creek and Moberly Bay was perhaps the most serious impairment in terms of its effect on other water uses. The use of the Blackbird Creek system as a wastewater carrier has precluded any other uses of this watershed. The offensive odour and objectionable appearance due to foam and dark brown colour of the creek have also degraded the aesthetic value of the surrounding area, as is evident from the numerous complaints by passing motorists. The dark brown colour and floating foam, which were visible in Moberly Bay to a distance of approximately 3/4 of a mile from the mouth of Blackbird Creek, adversely affect the aesthetic value of this area for any recreational purposes.

Examinations of bottom sediments in Jackfish Bay showed low concentrations of mercury although significant increases were noted in the organic content of the sediments. Biological investigation of the bay in 1969 also showed organic enrichment and revealed the absence of bottom fauna near the mouth of Blackbird Creek. This would indicate the presence of toxic substances in the mill wastes.

1.2 RECOMMENDATIONS

In an effort to alleviate the existing impairment in the Blackbird Creek system and Jackfish Bay as well as to reduce the input of polluting substances which on a long-term basis could contribute to a large scale degradation of water quality of Lake Superior, it is recommended that:

1. The Kimberly-Clark Pulp and Paper Company Limited undertake waste treatment programs to:

   a) Eliminate the aesthetic degradation resulting from the discharge of foam to the westerly arm of Jackfish Bay.

   b) Eliminate the aesthetic problems, due to the odour and the general appearance of Blackbird Creek near Highway No. 17 downstream from the mill.

   c) Eliminate toxic and tainting substances from its mill effluent.

   d) Develop alternative treatment methods to the existing Blackbird Creek system.

* *The company has installed culverts and landscaped the highway crossing area to alleviate the aesthetic impairment to a degree. However, additional work is required before these problems can be cleared up completely.*

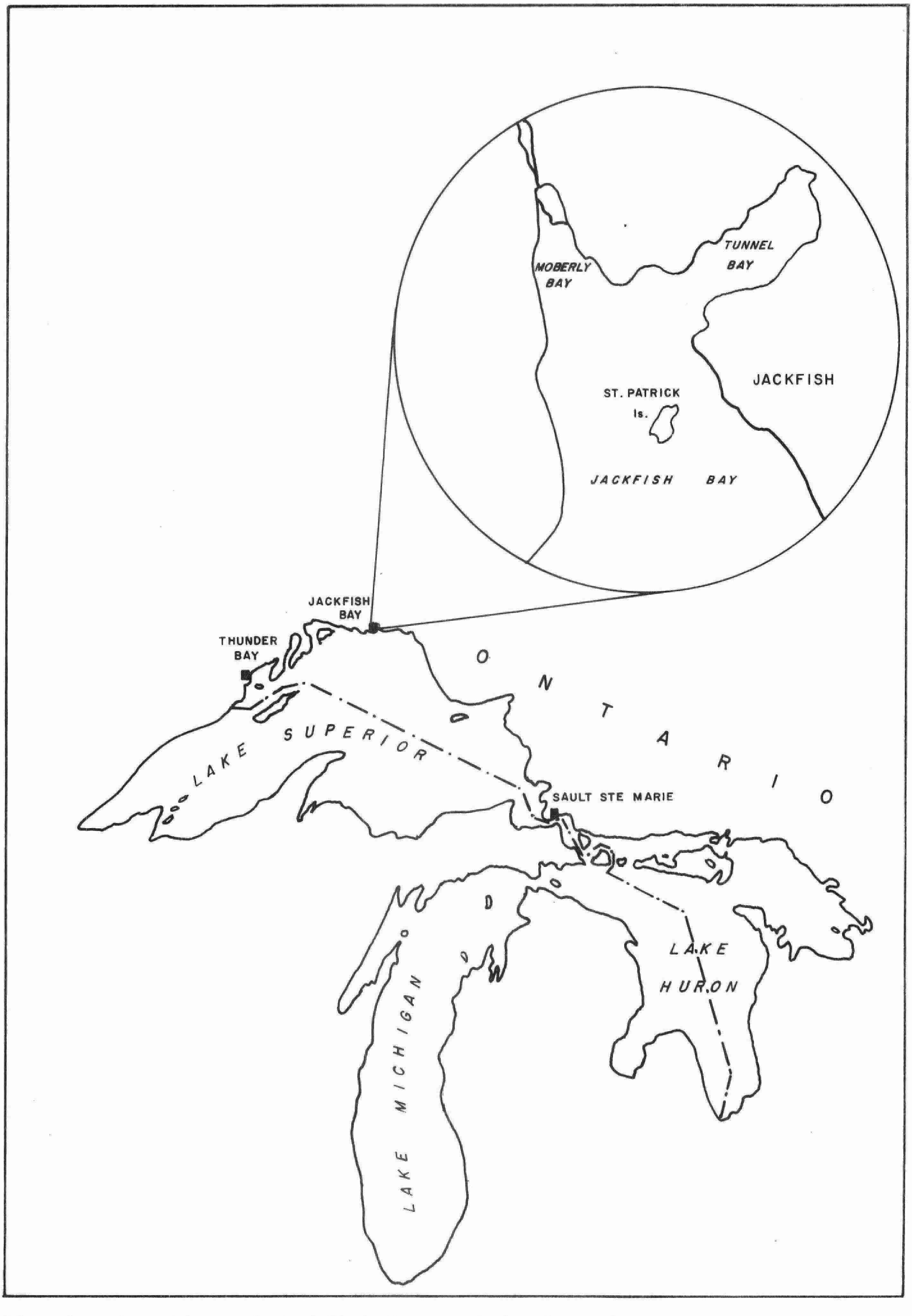

Fig. 1 Location of Jackfish Bay on Lake Superior

2. DESCRIPTION OF STUDY AREA

2.1 GENERAL DESCRIPTION

Jackfish Bay is located on the north shore of Lake Superior, approximately 150 miles east of the City of Thunder Bay. The general features of the bay and its drainage area are shown on Figure 2.1. The bay covers an area of approximately 4 square miles and is divided into two inner arms, Moberly Bay on the west and Tunnel Bay on the east. The former receives the drainage from the Blackbird Creek system which carries the wastewater discharges from the Kimberly-Clark Paper Company pulp mill at Terrace Bay. The latter receives the drainage from Jackfish Lake via a man-made tunnel which provides a connection between the inland lake and Jackfish Bay.

The Blackbird Creek drainage basin covers an area of about 24 square miles. The creek rises in the vicinity of the Town of Terrace Bay at an elevation of 900 feet and flows in a south-easterly direction for approximately ten miles to the northern-most tip of Moberly Bay at an elevation of 600 feet. Enroute to Moberly Bay, the creek passes through two small shallow lakes known as Lake A and Lake C. Lake A originally covered an area of 47 acres with depth ranging to 20 feet. Lake C, which is also called Moberly Lake, occupies an area of 69 acres and has a maximum depth of 21 feet.

2.2 WATER USES

The Blackbird Creek system is used as an open wastewater carrier for transporting the process wastes from the Terrace Bay bleached kraft pulp mill of the Kimberly-Clark Pulp and Paper Company to Moberly Bay. This practice has precluded any other uses of the system. The entire basin is located on the property of the Kimberly-Clark Pulp and Paper Company and the Company presently considers it to be its waste treatment system.

Process water for the mill and the Township of Terrace Bay is withdrawn from Lake Superior near Terrace Bay.

The Tunnel Bay arm and open waters of Jackfish Bay are used for sport fishing and pleasure boating by the summer residents of the community of Jackfish and tourists from a camp located on Jackfish Lake.

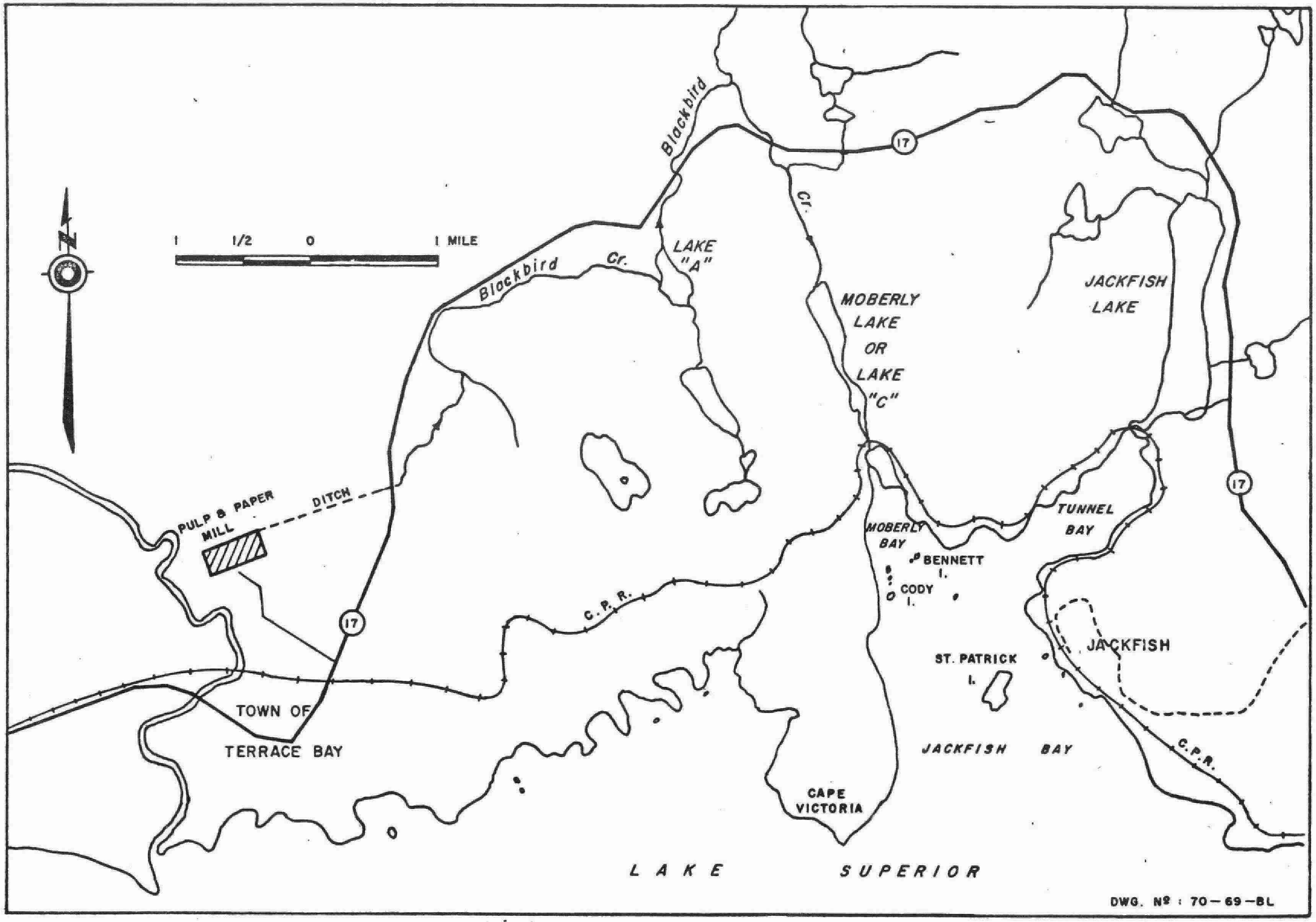

Fig. 2.1 Study Area Showing Blackbird Creek and Jackfish Bay

3. SURVEY OUTLINE

3.1 WATER QUALITY STUDY

Water samples for chemical and bacteriological analyses were collected from Jackfish Bay to define the nature and extent of the water quality impairment. The sampling station locations extended from the mouth of Blackbird Creek to a distance of approximately two miles into Jackfish Bay (Figure A.1). Samples were also collected from the Blackbird Creek basin upstream and downstream from Lakes A and C to evaluate the degree of treatment provided by the system. In addition, flow measurements were made near the mouth of the creek to obtain quantitative input of wastes into Moberly Bay.

Details on sampling methods and analytical results are provided in Appendices A and B, respectively.

3.2 SEDIMENT SAMPLES

Sediment samples were collected from selected water quality sampling stations to determine both the organic material content and possible presence of mercurial compounds in the bottom sediments. Details on the methods of collection and analytical results are presented in Appendices A and B, respectively.

4. FINDINGS AND DISCUSSION

4.1 WASTE SOURCES

During the water quality study on August 31 and September 1, 1970, the Terrace Bay mill of the Kimberly-Clark Pulp and Paper Company Limited discharged approximately 45.6 cfs of wastewater to Jackfish Bay. The dissolved solids, suspended solids, COD and BOD_5 contained in these wastewaters amounted to 320,000, 13,000, 204,000 and 91,000 lbs/day, respectively. A summary of the daily loadings from the mill is presented in Table B.1 of Appendix B. These loadings were calculated from the flow measurements and water quality data obtained near the mouth of Blackbird Creek. These loadings are somewhat higher than those reported in earlier mill surveys when it was assumed that water consumption by the mill was approximately equal to waste output. Usually waste inputs are measured at the source; however, since the company considers the Blackbird Creek system to be part of its waste treatment system, the loadings were based upon flows measured near the mouth of the creek.

Qualitative measurements of the mill wastewaters upstream and downstream from Lake A and Lake C revealed that the removal of oxygen-consuming wastes (BOD_5 and COD) in this system is insignificant. In fact, at the time of this study, the quality of the water downstream from the lakes was lower than the upstream quality. The only improvement that was noted was a decrease in suspended solids from approximately 105 mg/l at the first highway crossing downstream from the mill to 53 mg/l near the mouth of the creek.

4.2 WATER QUALITY

The water quality and aesthetic appearance of the Moberly Bay arm of Jackfish Bay have been impaired by the mill wastes. The most significant alterations in water quality noted during this study, were increases in the levels of oxygen-consuming wastes (BOD_5 and COD), nutrients and phenolic substances which are believed to partly contribute to tainting of fish flesh. For example, the BOD_5 and COD values showed an approximate two to three fold increase over background at a distance of 3/4 mile from the mouth of Blackbird Creek (Figure 4.1). The effects of the oxygen-consuming

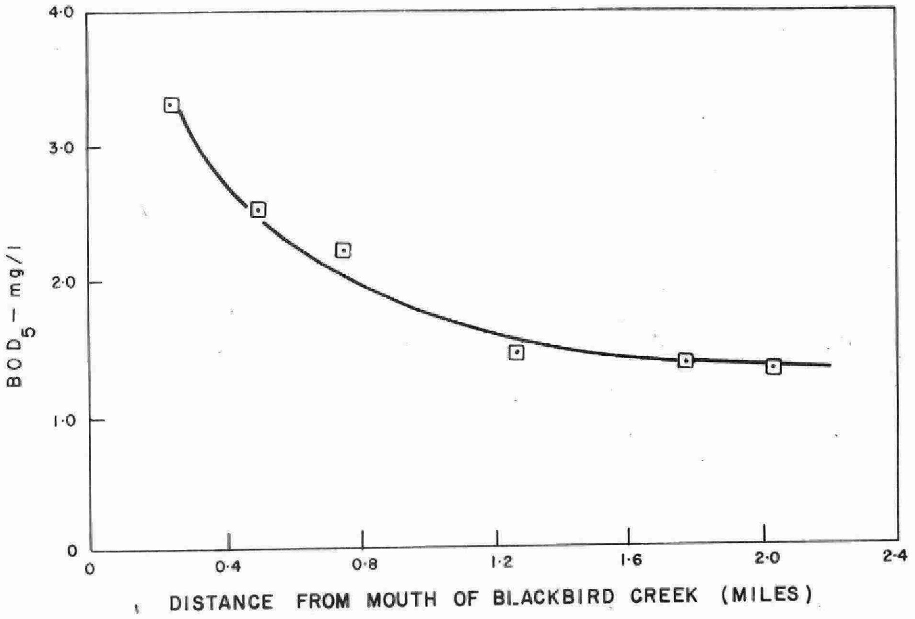

Fig. 4.1 BOD_5 Levels in Jackfish Bay

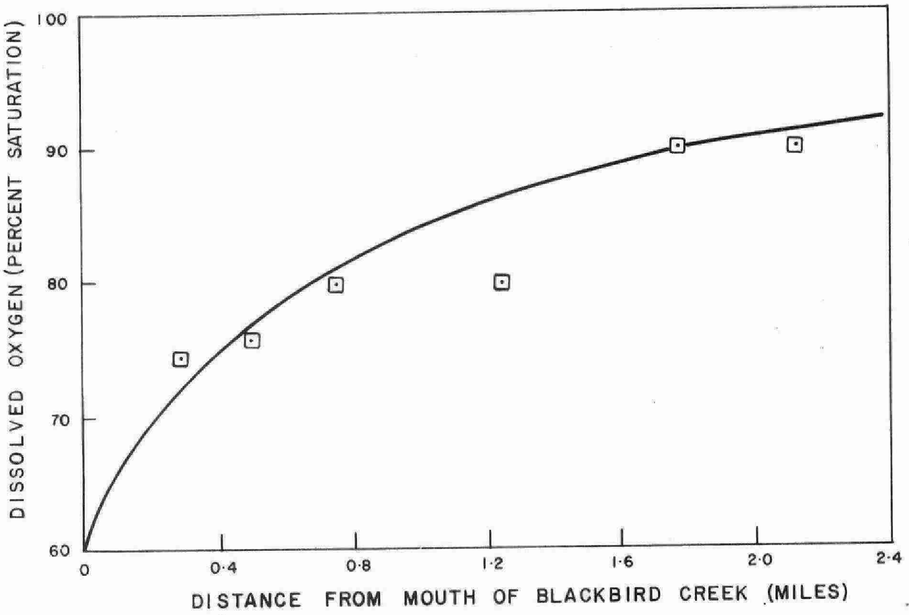

Fig. 4.2 Dissolved Oxygen Levels in Jackfish Bay

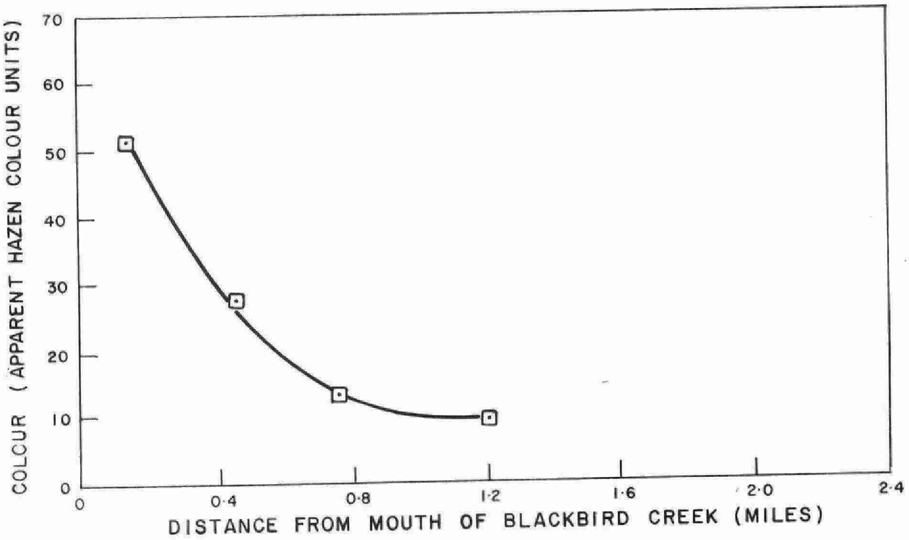

Fig. 4.3 Colour Levels in Jackfish Bay

wastes were reflected in dissolved oxygen levels which ranged from a low of approximately 60 percent saturation (6.0 mg/l) near the mouth of the creek to 78 percent saturation (7.2 mg/l) at 3/4 of a mile from the creek mouth in Moberly Bay (Figure 4.2). Farther away, the COD and BOD_5 levels decreased to near background while the dissolved oxygen levels increased to near saturation. On the basis of the survey results, it appears that the dissolved oxygen depression due to the mill wastes is not interfering with warm or cold water fisheries in the area.

Increases in the levels of turbidity, colour (Figure 4.3) and phenolic substances were detected to a distance of about 1¼ miles from the mouth of the creek. Beyond this distance, the levels decreased to near background. Comparison of samples collected from the surface with those obtained from 50 feet below surface at some of the stations did not reveal any consistent differences in water quality. This suggests that stratification between the top and bottom layers was not significant.

Increases in nutrient levels, total phosphorus and nitrogen, were detectable only in the immediate vicinity of the mouth of Blackbird Creek.

The bacterial contamination of the bay followed a pattern similar to that found for the alterations in chemical parameters previously discussed. Total coliform counts ranged from a median of 2,400 organisms/100 ml at 3/4 mile from the mouth of the creek to a median of about 100 organisms/100 ml at a distance of 1¼ miles from the mouth of the creek. Fecal coliform counts were generally less than 4 organisms/100 ml in the entire bay. Fecal streptococci counts ranged from less than 4 to 36 organisms/100 ml within a distance of about 3/4 mile from the creek mouth to less than 12 organisms/100 ml farther out. These findings indicate that at the time of this study, bacterial contamination in excess of the criterion of 1,000 total coliforms per 100 ml for swimming and bathing was restricted to a portion of Moberly Bay only.

The bacteriological criteria used by this Ministry for specific uses are presented in the publication "Guidelines and Criteria for Water Quality Management in Ontario". The criteria for swimming and bathing are defined as geometric means based upon at least ten samples per month (including samples collected during weekend periods). The geometric mean levels considered acceptable are 1,000 coliform organisms per 100 ml, 100 fecal coliform organisms per 100 ml and 20 enterococcus (fecal streptococci) organisms per 100 ml. When comparing the survey data with these criteria, it must be acknowledged that sufficient numbers of bacteriological samples to meet the geometric mean requirements of the above mentioned criteria were not collected. However, comparisons with the criteria provide an indication of the relative magnitude of the bacteriological water quality problems.

The main impairments in the aesthetic value of Moberly Bay were the dark brown colour of the wastewaters, increases in turbidity and floating foam which were visible for a distance of approximately three quarters of a mile from the mouth of Blackbird Creek during offshore wind conditions. The unpleasant appearance would also degrade the value of the Moberly Bay area for recreational uses. At the first highway crossing, Blackbird Creek was covered with foam and was dark brown in colour. The stream also had an offensive stench which has been the object of numerous complaints by passing motorists.

Although toxicity tests were not conducted during this survey, an earlier biological evaluation of Jackfish Bay revealed the absence of all bottom fauna near the mouth of Blackbird Creek. This finding suggests that the mill wastewater discharges are toxic to the aquatic life and control measures should be considered to alleviate this condition. Examinations of fish tainting have not been conducted although kraft mill effluents have been shown to contribute to tainting of fish flesh.

4.3 SEDIMENTS

The physical characteristics of the bottom sediments collected from Jackfish Bay were highly variable ranging from soft dark coloured sludge near the mouth of Blackbird Creek in Moberly Bay to mixtures of gravel silt and clay farther out into the bay. The analytical results also exhibited wide variations particularly in organic matter content. Although definite patterns could not be established, there did appear to be an increase in the organic content of the sediments in the Moberly Bay and the westerly side of Jackfish Bay as far out as stations 11 and 12 (Figure A.1).

The mercury content of the sediments was generally low ranging from less than 0.01 mg/kg to 0.14 mg/kg. These levels are comparable to background levels in Lake Superior.

5. WATER QUALITY CONTROL

The waters of Lake Superior to date have been relatively unaffected by pollution except on a localized basis in inshore areas. This has been due more to the lack of development around the lake than to any concern for its ecostructure. However, continuing growth and development will exert increasing pollution pressures on this system. Therefore, comprehensive water quality management programs including stringent water quality standards should be established to protect this valuable resource from the degradation that has occurred in the lower Great Lakes.

5.1 PROPOSED WATER QUALITY STANDARDS

In the case of Jackfish Bay, the water quality impairment is now restricted to a relatively small inshore area of Lake Superior. However, the continuing discharge on a long-term basis of nutrient materials such as organic carbon, nitrogen and phosphorus can contribute to the degradation of the offshore waters. In addition, the effects of tainting compounds (e.g. phenolic substances) may be felt on a wider basis due to the mobility of fish populations.

Control of the various pollutants for long-term protection should, therefore, be given high priority in water quality management programs for the lake. For example, although the organic wastewater discharges (BOD_5) did not appear to have significant effects on the dissolved oxygen levels in the area, these wastes should be controlled to avoid the risk of build-up of carbonaceous materials on a long-term basis.

At this time, the Canadian and U.S. authorities have not finalized standards for the open waters of Lake Superior, although the objectives developed by the IJC for the Lower Great Lakes may be used as the minimal basis for the Upper Lakes. It is expected, however, that a non-degradation policy with stringent water quality standards is being discussed and probably will be established in conjunction with the upcoming IJC study of the Upper Great Lakes. Water quality criteria have already been suggested by the Lake Superior Water Quality Technical Committee.*

---

* *Meeting on May 28, 1970 - representatives of FWQA, Michigan Water Resources Commission, Minnesota Pollution Control Agency, Wisconsin Department of Natural Resources and Canadian Federal and Provincial representatives as observers.*

Interim standards compatible with these criteria are presented in Sections A and B for Jackfish Bay. Sub-section i) presents standards which apply to waters within a 3/4 mile distance from the mouth of Blackbird Creek with the exception of a mixing zone which will be defined by the Ministry of the Environment. The standards in sub-section ii), which apply to waters at periphery of the 3/4 mile distance from the mouth of Blackbird Creek and which are more stringent than the IJC objectives, imply considerable improvement in water quality with increasing distance towards open waters of Jackfish Bay. If the specified standards are met, it is believed that restoration of water quality to near background levels should occur within a reasonable distance beyond the 3/4 mile periphery.

General standards dealing mainly with aesthetic aspects and which are applicable to both sub-sections i) and ii) are presented in Section B of Table 5.1.

TABLE 5.1

PROPOSED WATER QUALITY STANDARDS FOR SECTIONS OF JACKFISH BAY

A. SPECIFIC STANDARDS

Parameter	i) Waters within 3/4 mile distance from mouth of Blackbird Creek *(1)*	ii) Waters at 3/4 mile away from mouth of Blackbird Creek
Dissolved oxygen	6.0 mg/l mid-June to mid-September 7.0 mg/l mid-September to mid-June *(2)*	9 mg/l
Turbidity	10 Jackson Turbidity units (JTU)	5 JTU
pH	6.5 - 8.5	6.5 - 8.5
Phenolic substances	0.001 mg/l	0.001 mg/l
Toxic substances	Toxic substances must not be added in concentrations or combinations that are toxic to human, animal or plant life *(3)*.	
Microbiological (Membrane Filter Technique) *(4)*:		
Total coliform	1,000/100 ml	100/100 ml
Fecal coliform	100/100 ml	100/100 ml
Fecal streptococcus	20/100 ml	20/100 ml

(1) *These standards apply to all waters within 3/4 mile from the mouth of Blackbird Creek with the exception of a mixing zone which will be defined by the Ministry of the Environment.*

(2) *The dissolved oxygen level of 7.0 mg/l is required during spawning periods between mid-September and mid-June.*

(3) *Refer to OWRC "Guidelines and Criteria for Water Quality Management in Ontario".*

(4) *The limits are expressed as geometric mean densities based on at least 10 samples per month.*

B. GENERAL STANDARDS

i) Tainting substances - all materials that impart odour or taste to fish or edible invertebrates shall be excluded from the water at levels determined to produce tainting.

ii) Taste - all substances that will impart an objectionable taste to the water shall be excluded from the water.

iii) Odour causing materials that are not readily removable by conventional water treatment consisting of coagulation, flocculation, sedimentation, rapid sand filtration and chlorination shall not be discharged to the waters of the study area.

iv) Oil, petrochemicals or other immiscible substances that will cause visible films or toxic, noxious, or nuisance conditions shall not be discharged to the water.

v) Nutrients from unnatural sources which will stimulate the overproduction of algae, nuisance vegetation, or offensive slime growths shall not be discharged to the water.

vi) Temperature - the normal daily and seasonal temperature variations that were present before the addition of heat due to other than natural causes shall be maintained.

Heated discharges to the water will not be permitted unless it is clearly demonstrated that heated effluents will enchance the usefulness of the water resource without endangering the production and optimum maintenance of wildlife, fish and other aquatic species. It shall be the responsibility of the user to provide evidence to support the acceptability of the discharge under these terms.

Heat may not be discharged in the vicinity of spawning areas or where increased temperature might interfere with recognized movement of spawning or migrating fish populations.

vii) Settleable materials - substances shall not be added that will adversely affect the aquatic biota or will create objectionable deposits on the bottom or shore of the river.

viii) Water uses in the Jackfish Bay region should be controlled to prevent the degradation of existing high quality water through the significant increase in concentration of hardness, chlorides, suspended materials, turbidity and other parameters indicative of water quality degradation.

APPENDIX A

METHODS

APPENDIX A

METHODS

A.1 WATER QUALITY SAMPLING

Two sampling stations, one at the first crossing of Highway 17 downstream from the mill and the other near the mouth of Blackbird Creek, were set up for this study to evaluate the effectiveness of the waste treatment provided by Lakes A and C along the Black Creek system. These stations were sampled at 4 to 6 hour intervals and composited over a 12-hour period.

Twenty-two sampling stations were selected in Jackfish Bay to evaluate the extent of water quality impairment caused by the mill wastes. The locations of the sampling stations which are shown on Figure A.1 were marked with floating buoys to ensure that the same locations could be sampled during the various sampling runs. Four sets of grab samples for chemical analysis were collected at 6 hour intervals during daytime periods from the 14 stations located within a 1.25 mile distance from the mouth of Blackbird Creek. The stations farther out were sampled at 12-hour intervals. Bacterial samples were also obtained at 12-hour intervals. Most of the stations located in deep water were sampled at the surface as well as at 50 feet below surface (using a Kemmerer sampler) to examine if significant variation in water quality occurred with depth.

Analytical results and parameters for which the samples were analyzed are presented in Tables B.1, B.2 and B.3 of Appendix B.

A.2 SEDIMENT SAMPLES

Sediment samples were collected from stations 3, 6, 8 to 16 and 18 with Ponar dredge. One core sample was also obtained near the mouth of Blackbird Creek. These were analyzed for mercury and organic material content (percent volatile solids). Analytical results are presented in Table B.4 of Appendix B.

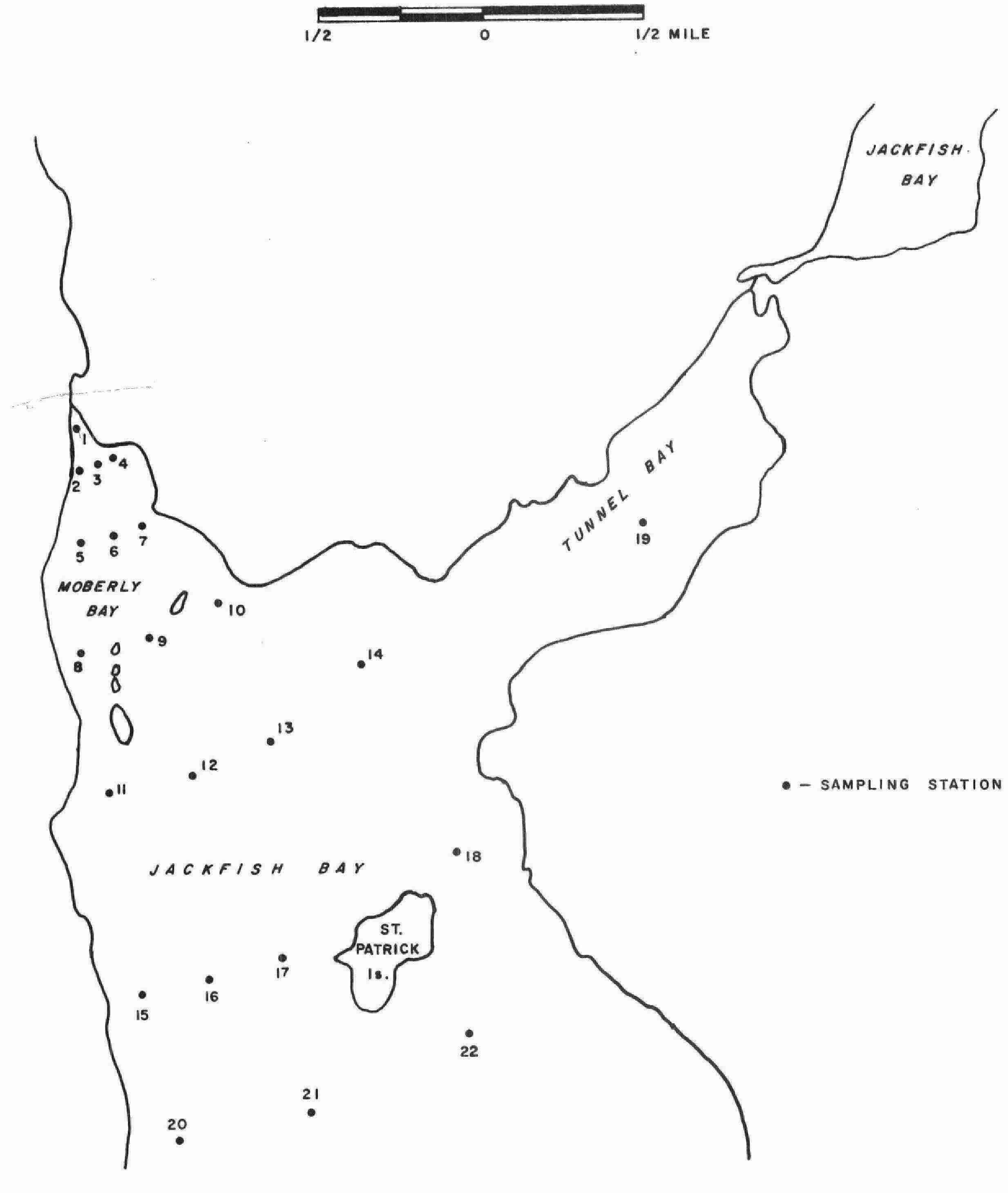

Fig. A.1 Locations of Sampling Stations in Jackfish Bay

APPENDIX B

TABLE B.1 WASTE LOADINGS FROM THE TERRACE BAY MILL OF THE KIMBERLY-CLARK PULP AND PAPER COMPANY LIMITED

Parameter	August 31, 1970		September 1, 1970		Average	
	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day
Dissolved solids	1,314	331,100	1,294	310,000	1,304	320,000
Suspended solids	58	14,620	48	11,500	53	13,000
BOD_5	260	65,500	320	77,000	290	71,000
COD	840	207,000	840	200,000	840	204,000
Phenolic substances	0.67	170	0.67	160	0.67	165
Total Phosphorus	0.21	53	0.21	50	0.21	52
Total Nitrogen	2.2	550	2.2	480	2.2	515
Flow	46.7 cfs		44.5 cfs		45.6 cfs	

TABLE B.2 SUMMARY OF WATER QUALITY DATA, 1970, - JACKFISH BAY

Station Location	Dissolved Oxygen % Saturation	BOD_5	Solids		COD	Sulphates	Phenolic Substances	Colour	pH	Turbidity (Jackson Units)
		mg/l	Total	Suspended	mg/l	mg/l	µg/l	Hazen Colour Units		
			mg/l							
Blackbird Creek	-	175	1,100	105	695	15	550	1,375	6.2	> 150
Moberly Bay (Station)										
1	60	240	1,300	26	845	11	670	> 2,500	6.7	> 150
2	71	3.9	76	4	23	4	19	46	7.4	4
3	75	2.5	79	7	19	4	13	45	7.3	3
4	75	3.1	80	3.5	24	4.2	2	56	7.3	4.5
5	75	2.7	75	2.7	20	2.1	16	36	7.3	3.1
6	77	2.6	76	4	16	2.7	17	31	7.2	4.9
7	77	2.0	75	3.5	21	3	14	40	7.3	3
8	77	2.9	80	6.6	21	2.2	11	28	7.3	2.5
9	80	2.1	74	7	12.5	2	10	23	7.2	3
10	78	1.6	69	4.6	< 10	1	5	15	7.4	2
11	75	1.8	67	8	< 10	1.5	5	11	7.2	1.7
12	76	1.4	79	6	< 10	1	3.3	< 10	7.1	1.8
13	75	1.4	75	5	< 10	1	1	< 10	7.2	4.1
14	81	1.3	76	5	< 10	1	0	< 10	7.2	1.6
15	77	1.4	70	7	< 10	1	< 1	< 10	7.2	1.8
16	72	1.4	60	5	< 10	2	< 1	10	7.3	1.5
17	90	1.4	83	7.5	< 10	1	7.5	< 10	7.0	2.5
18	90	1.2	78	5	< 10	1	0	< 5	7.2	1.8
19	94	1.3	90	5	< 10	1	0	< 5	7.1	1.3
20	86	1.6	80	5	< 10	1	0	< 5	7.3	1.8
21	96	1.3	83	5	< 10	1	0	< 5	7.0	1.8
22	82	1.2	105	5	< 10	1	0	< 5	6.9	1.5

Station Location	Bacteriological Enumeration *			Phosphorus		Nitrogen			
	Total Coliforms	Fecal Coliforms	Fecal Streptococci	Total	Soluble	Free NH_3	Total Kjel.	Nitrite	Nitrate
	per 100 ml			mg/l		mg/l			
Blackbird Creek	-	-	-	0.185	0.110	0.38	1.2	0.07	0.03
Moberly Bay (Station)									
1	-	-	-	0.21	0.098	0.33	2.06	0.11	0.04
2	3,900	< 4	36	0.20	0.011	0.01	0.25	0.006	0.16
3	2,200	< 4	12	0.01	0.006	< 0.01	0.17	0.006	0.21
4	2,400	< 4	8	0.013	0.008	< 0.01	0.23	0.006	0.20
5	2,200	< 4	14	0.012	0.007	< 0.01	0.20	0.006	0.20
6	800	< 4	< 4	0.021	0.01	< 0.01	0.20	0.006	0.22
7	1,200	< 4	6	0.019	0.004	< 0.01	0.20	0.005	0.21
8	2,000	< 4	16	0.012	0.005	< 0.01	0.18	0.006	0.19
9	484	< 4	20	0.01	0.007	< 0.01	0.16	0.004	0.21
10	168	< 4	4	0.008	0.005	< 0.01	0.20	0.004	0.21
11	220	< 4	6	0.009	0.005	< 0.01	0.15	0.004	0.26
12	86	< 4	6	0.015	0.005	< 0.01	0.40	0.004	0.24
13	72	< 4	< 4	0.011	0.006	< 0.03	0.24	0.003	0.26
14	26	< 4	< 4	0.007	0.004	0.01	0.11	0.003	0.28
15	46	< 4	< 4	0.013	0.002	0.06	0.22	0.002	0.20
16	250	< 4	< 8	0.012	0.01	0.04	0.10	0.004	0.26
17	N.A.	< 4	< 4	-	0.003	0.02	0.24	0.003	0.25
18	12	< 4	< 4	0.012	0.005	0.02	0.15	0.003	0.27
19	16	6	12	0.007	0.003	0.01	0.18	0.003	0.28
20	40	< 4	< 4	0.013	0.005	< 0.01	0.14	0.003	0.28
21	14	< 4	< 4	0.013	0.004	< 0.01	0.11	0.002	0.28
22	10	< 4	< 4	0.015	0.005	0.01	0.14	0.003	0.29

* Means

TABLE B.3 CONTENT OF ORGANIC MATTER AND MERCURY IN SEDIMENTS - JACKFISH BAY

Station No.	Depth of Sediments (inches)	Percent Organic Matter	Mercury mg/kg
Near mouth of Blackbird Creek	0 - 3	5.1	0.018
	3 - 6	6.0	0.031
	6 - 9	3.6	0.011
	9 - 12	2.2	0.016
	12 - 15	3.1	0.014
	15 - 18	3.1	0.01
	18 - 21	4.2	0.012
	21 - 24	3.0	0.012
	24 - 27	2.6	<0.01
	27 - 30	5.9	0.00
Moberly Bay (Station)			
3	Surface	3.0	0.051
6	"	17.6	0.10
8	"	6.0	0.031
9	"	7.2	0.029
10	"	0.9	0.020
11	"	10.2	0.030
12	"	5.5	0.12
13	"	1.4	0.020
14	"	3.6	0.031
15	"	5.0	0.11
17	"	4.9	0.14
18	"	5.1	0.018